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COLLIER'S FERRY PUMP STATION GEOTECHNICAL BASELINE REPORT

Prepared for:

City of Beaumont, Texas

NOVEMBER 12, 2021

STATE OF TEXAS
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LICENSED
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11/12/2021

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FNI PROJECT NO. BMT20326

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1.0 INTRODUCTION

This Geotechnical Baseline Report (GBR) describes the subsurface conditions that can be assumed during bidding and construction of the microtunnels and shafts associated with the construction of the Collier's Ferry Pump Station Project (Project) located in Beaumont, Texas for the City of Beaumont, Texas (Owner). The Owner has retained Freese and Nichols, Inc. (Engineer) to perform the professional design services that included the development of this GBR.

1.1 DESCRIPTION OF THE PROJECT

The Owner requested the Engineer's assistance to provide professional engineering services in connection with the design of a new 45 MGD raw water pump station to be named the Collier's Ferry Pump Station. The Project includes a microtunnel to connect the forebay of the existing pump station (Lawson Raw Water Pump Station) to the Collier's Ferry Pump Station. The proposed microtunnel will convey raw water to the Collier's Ferry Pump Station by gravity. The microtunnel will be 48 inches in inside diameter, approximately 2,500 feet in length, and have a depth of cover that varies from 12 feet to nearly 35 feet.

1.2 SCOPE AND PURPOSE OF THE GEOTECHNICAL BASELINE REPORT

This GBR summarizes the geotechnical basis for design and construction of the microtunnel and shaft excavations as shown in and described by the Drawings and Specifications. This GBR is only applicable to the microtunnel and shaft excavations (including the Wet Well shaft excavation) associated with the Project and is not applicable to any other elements of the Project. This GBR was prepared and based on data obtained from a geotechnical investigation that was performed by Tolunay-Wong Engineers, Inc., a subconsultant of the Engineer. Detailed information of the geotechnical investigation is provided and summarized in the Geotechnical Data Report (GDR) for this Project.

This GBR establishes a contractual statement of the subsurface conditions, which are referred to as the baseline conditions. The contractual baseline conditions presented herein do not represent warranties by the Owner or the Engineer of the actual subsurface conditions that will be encountered by the Contractor. Rather, the purpose of this GBR and its stated baseline conditions is to translate the results of the geotechnical investigation and previous experience into clear, definitive, and verifiable descriptions of the anticipated subsurface conditions upon which the Contractor may rely, including when submitting a bid. Through the baseline conditions, this GBR establishes the allocation of risk between the Owner and Contractor for the actual conditions encountered during construction. The Contractor is responsible for the actual conditions less adverse and up to the stated baseline conditions herein, while the Owner is responsible for the actual conditions more adverse than the stated baseline conditions herein. This GBR is the sole document for interpretations of the subsurface conditions for the design and construction of the microtunnels and shafts associated with this Project and provides the basis for determining the merit of claims related to differing site conditions, if such occur.

The overall purpose of this GBR is to:

- Establish baselines for geotechnical conditions, including, but not limited to soil, rock, and groundwater conditions, and the behavior of such materials that can be assumed to be encountered during construction by the Contractor.
- Identify selected principal design and construction considerations, key project constraints, and selected requirements that a Contractor needs to address during bid preparation and construction.
- Provide guidance to the Owner and Engineer, and their representatives, in administering the Contract and monitoring the Contractor's performance during construction.

This GBR references the GDR that presents factual details of the geotechnical investigation and laboratory testing performed on material samples collected during the geotechnical investigation, including detailed descriptions of the field and laboratory testing data, methods, and procedures. This GBR, and the referenced GDR, are included as Contract Documents for this Project. If there are any inconsistencies between this GBR and the GDR, this GBR shall take precedence. This GBR was developed based on the suggested guidelines presented in *Geotechnical Baseline Reports for Construction* prepared by the Technical Committee on Geotechnical Reports of the Underground Technology Research Council of the Construction Institute of the American Society of Civil Engineers (ASCE 2007).

This GBR is not intended to present the minimum required design or standards of construction contained in the Contract Documents. Nothing in this GBR should be construed as amending or altering the Contract Documents, relaxing the standards of construction, or modifying the Contractor's responsibilities according to the Contract Documents. The technical concepts, terms, and descriptions in this report follow standards commonly used in geotechnical engineering and/or engineering geology which have specific meaning pertaining to the Work. Bidders should have a qualified and experienced geotechnical engineer or engineering geologist carefully review this GBR so that a complete understanding of the information presented herein is developed prior to submitting a bid. In addition, bidders shall review all of the Contract Documents, including this GBR and the associated GDR, to make decisions concerning the planning of the

Work, and the means, methods, techniques, sequences, and procedures of construction required to complete the Work.

This GBR is based upon several assumptions regarding the means, methods, and sequence of construction, and the level of workmanship to be employed by the Contractor. The anticipated behavior of subsurface materials as described herein will be influenced by the means and methods selected by the Contractor to be used during construction; and therefore, the behavior of the subsurface materials may vary from that described herein. Contractor shall evaluate the subsurface conditions described herein as they relate to, and interact with, the proposed means and methods selected by the Contractor for construction. Any means and methods proposed by the Contractor where the Contractor believes the baseline condition(s) presented herein become invalid or require modification shall be raised by the Contractor and discussed with the Owner and Engineer during the bid phase prior to the bid opening date. Contractor has a duty to inform the Owner and Engineer of the baseline condition(s) that the Contractor believes are invalid or require modification during the bid phase.

1.3 WARRANTY STATEMENT OF THE GEOTECHNICAL BASELINE REPORT

The baseline condition statements provided in this GBR were developed based on geotechnical information gathered through a geotechnical investigation and associated laboratory and field testing, as well as other relevant factors such as regional engineering and construction experience. The judgement applied in the interpolation and extrapolation of this information reflects the view of the Engineer in establishing the baselines. Therefore, the baseline condition statements presented herein are not necessarily to be considered geotechnical facts. The values associated with the baseline condition statements are presented for bidding purposes. In the interpolation of the data, it has been assumed that the Contractor will employ applicable and appropriate means, methods, and sequences of construction and an industry accepted level of workmanship according to the Contract Documents.

2.0 SITE CONDITIONS AND GENERAL BASELINES

2.1 SURFACE CONDITIONS

Surface topography in the vicinity of the Project site is generally relatively flat as it is located immediately adjacent and along the western bank of the Neches River. An existing unpaved access road extends along the western bank of the Neches River from Collier's Ferry Park to the existing Lawson Raw Water Pump Station. Collier's Ferry Park is parkland which contains asphalt paved roadways and parking lots, small park buildings and shelters, and adjacent mowed areas. Forested wetlands are located south of the existing access road and eastern portion of Collier's Ferry Park.

2.2 GEOLOGIC CONDITIONS

Beaumont, Texas is located within the Gulf Coastal Plain of Texas, which is underlain by a large mass of sediments that are gently sloping towards the Gulf of Mexico. The Project site is adjacent to the Neches River which has a broad alluvial valley and empties directly into the Gulf of Mexico. The site is located within alluvium or the Beaumont Clay formation, which is made up of poorly bedded, marly clay, and is interbedded with lenses of sand. The Beaumont Clay is contemporaneous with the Beaumont Sand formation, which can be generally continuous on a local scale. The Beaumont Clay and Beaumont Sand were deposited largely by rivers (TWDB 2006). The subsurface at the site is primarily within alluvium or the Beaumont Sand formation (UTABEG 1992).

2.3 SUBSURFACE CONDITIONS

The interpretations of the subsurface conditions along the microtunnel alignment are shown in Appendix A. Soil descriptions and unit symbols on the profiles were generalized from the detailed descriptions on the boring logs contained in the GDR.

The behavior of the soils along the microtunnel and shaft excavations will affect the selection of the Contractor's means, methods, and sequences of construction. The behavior of the soils encountered depends upon several factors including, but not limited to the gradation and texture of the soil materials (e.g. the percentage and plasticity of fine materials contained in the soil), consistency of the soil materials, relative density of the soil materials, groundwater conditions, orogenesis of the soil materials (depositional environment), and the means, methods, and sequences of construction employed by the Contractor within the soil materials. The Tunnelman's Ground Classification (Heuer 1974) was used to anticipate the ground behavior for the microtunnel and shaft excavations and is used in the baselines of the soil descriptions in the following sections. The Tunnelman's Ground Classification is presented in Table 1 below for reference.

2.4 GROUNDWATER CONDITIONS

Based on the geotechnical investigation and due to the proximity of the Neches River to the site, the following baseline shall apply to the groundwater conditions for the microtunnel and shaft excavations for the Project:

The groundwater elevation shall be assumed to be at the ground surface for the entire length of the microtunnel and at the ground surface for each of the shaft excavations.

2.5 FAULTS

Growth faults have been observed in the region that parallel the Texas Gulf Coast. Salt domes are also present in the region, which can locally penetrate shallow depths. Both faults and salt domes are primarily formed by gravity acting on the large mass of sediments that were deposited on abnormally pressured shale or salt deposits. However, no evidence of faulting or salt domes are currently present at the site, therefore the following baseline shall apply to the presence of faults for the microtunnel and shaft excavations for the Project:

No faults are to be encountered along the length of the microtunnel alignment or at shaft excavations.

2.6 COBBLES, BOULDERS, AND OBSTRUCTIONS

Cobbles, which are defined as rock fragments with dimensions between 3 inches to 12 inches, or boulders, which are defined as rock fragments with dimensions of 12 inches or more, are not anticipated to be encountered based on the geology of the region. Obstructions, which are defined as any buried object, of natural origin or man-made, that lies completely or partially within the cross section of the microtunnel and that impedes continued forward progress along the design path within allowable tolerances. An unknown obstruction was found during drilling of Boring TB-1 as noted in the GDR. Therefore, the following baseline shall apply to the presence of cobbles, boulders, and obstructions for the microtunnel and shaft excavations for the Project:

No cobbles and boulders are to be encountered along the length of the microtunnel alignment or at shaft excavations. Cemented sands, regardless of size, shall be considered incidental to the Work. For each microtunnel excavation (drive), obstructions 18 inches or smaller shall be considered incidental to the Work and one (1) obstruction greater than 18 inches shall be assumed to be encountered by the Contractor. For each shaft excavation, obstructions 24 inches or smaller shall be considered incidental to the Work and one (1) obstruction greater than 24 inches shall be assumed to be encountered by the Contractor. Contractor shall utilize appropriate excavation and construction means and methods to handle obstructions. The size of the cobbles, boulders, or obstructions herein are as measured by the longest dimension of the encountered cobble, boulder, or obstruction.

2.7 ENVIRONMENTAL CONTAMINATION

No sources of environmental contamination are known to exist in proximity of the microtunnel and shaft excavations, therefore the following baseline related to environmental contamination shall apply for the microtunnel and shaft excavations for the Project:

All soil and groundwater encountered for the microtunnel and shaft excavations are not considered to be contaminated per applicable environmental regulations and therefore no special handling, hauling, or disposal is to be required to be performed for the soil and groundwater encountered.

Table 1: Tunnelman's Ground Classification (Heuer 1974)

Classification		Behavior	Typical Soil Types
Firm		Heading can be advanced without initial support, and [the] final lining can be constructed before [the] ground starts to move.	Loess above the water table; hard clay, marl, cemented sand and gravel when not highly overstressed.
Raveling	Slow Raveling	Chunks or flakes of material begin to drop out of the arch or walls sometime after the ground has been exposed, due to [the] loosening or to overstress and "brittle" facture (ground separates or breaks along distinct surfaces, opposed to squeezing ground). In fast raveling ground, the process starts within a few minutes, otherwise the ground is slow raveling.	Residual soils or sand with small amounts of binder may be fast raveling below the water table, slow raveling above. Stiff fissure clays may be slow or fast raveling depending upon [the] degree of overstress.
	Fast Raveling		
Squeezing		Ground squeezes or extrudes plastically into [the] tunnel, without visible fracturing or loss of continuity, and without perceptible increase in water content. Ductile, plastic yield and flow due to overstress.	Ground with low frictional strength. Rate of squeeze depends on degree of overstress. Occurs at shallow to medium depth in clay of very soft to medium consistency. Stiff to hard clay under high cover may move in combination of raveling at execution surface and squeezing at depth behind surface.
Running	Cohesive-Running	Granular materials without cohesion are unstable at a slope greater than their angle of repose (± 30° - 35°). When exposed at steeper slopes they run like granulated sugar or dune sand until the slope flattens to the angle of repose.	Clean, dry granular materials. Apparent cohesion in moist sand, or weak cementation in any granular soil, may allow the material to stand for a brief period of raveling before it breaks down and runs. Such behavior is cohesive-running.
	Running		
Flowing		A mixture of soil and water flows into the tunnel like a viscous fluid. The material can enter the tunnel from the invert as well as from the face, crown, and walls, and can flow for great distances, completely filling the tunnel in some cases.	Below the water table in silt, sand, or gravel without enough clay content to give significant cohesion and plasticity. May also occur in highly sensitive clay when such material is disturbed.
Swelling		Ground absorbs water, increases in volume, and expands slowly into the tunnel.	Highly preconsolidated clay with plasticity index in excess of about 30, generally containing significant percentages or montmorillonite.

3.0 CONDITIONS AND BASELINES FOR PROJECT ELEMENTS

This Project includes construction of a microtunnel, which consists of two (2) separate segments (drives) and construction of three (3) separate shafts to facilitate construction of the microtunnel and construction of a wet well. Microtunnel Segment 1 extends from approximately STA 1+30 (location of Shaft 1) to approximately STA 13+45 (location of Shaft 2) as shown on the Contract Documents. Microtunnel Segment 2 extends from approximately STA 13+45 (location of Shaft 2) to approximately STA 26+47 (location of Shaft 3, which also serves as the Wet Well Shaft for the Collier's Ferry Pump Station) as shown on the Contract Documents.

Data from thirteen (13) borings was used to characterize the subsurface conditions for the proposed microtunnel and shaft excavations for this Project, to make interpretations of the subsurface conditions, and to further define the baseline conditions for the microtunnel and shaft excavations as presented herein. The microtunnel excavation will encounter mixed face conditions and various soil types. The types of soil (in accordance with Unified Soil Classification System (USCS)) to be encountered along the alignment include fat clay (CH), organic clay (OH), clayey sand (SC), poorly graded sand (SP), and poorly graded sand with silt (SP-SM). Shaft 1 will encounter approximately 20 feet of clayey sand (SC) overlain by poorly graded sand with silt (SP-SM). Shaft 2 will encounter approximately 6 feet of fat clay (CH) overlain by approximately 12.5 feet of clayey sand (SC), which is overlain by another thin 2-foot-thick layer of fat clay (CH). Shaft 3 will encounter approximately 4 feet of fat clay (CH) overlain by approximately 7 feet of lean clay (CL), which is overlain by approximately 5 feet of clayey sand (SC), which is overlain by fat clay (CH).

The baseline soil conditions as shown in Table 2 below shall apply for the subsurface materials to be encountered for the microtunnel and shaft excavations for the Project:

Table 2: Baseline Soil Conditions

Baseline Soil Condition Parameter (Units)	Mean Baseline Value	Range
Moist Unit Weight (PCF)	127	105 to 136
Moisture Content (%)	23	16 to 38
Liquid Limit	50	21 to 94
Plasticity Index	47	9 to 94
SPT Blow Count	12	0 to 28
Shear Strength (PSF)	4,250	600 to 6,000
Swell (%)	0.4	0.0 to 1.2

The following baselines related to subsurface conditions shall apply for the microtunnel and shaft excavations for the Project:

- The Tunnelman’s Ground Classification for the soils associated with the microtunnel and shaft excavations are to be considered fast raveling to flowing due to the variability of the clay content of the soils and such soils are located below the groundwater level.
- The soils associated with the microtunnel and shaft excavations are to be considered “Type C” soils in accordance with OSHA (29 CFR Part 1926, Subpart P – Excavations).
- The soils associated with the microtunnel and shaft excavations are to be highly abrasive in accordance with the Soil Abrasion Test as further described in the GDR.
- Groundwater inflow quantities have not be baselined for the microtunnel and shaft excavations as the Contractor is required by the Contract Documents and herein to control groundwater through the use of pressurized face microtunneling, jacking pipe with water tight joints, and watertight initial support systems for shaft excavations.

4.0 CONSTRUCTION CONSIDERATIONS FOR PROJECT ELEMENTS

The Contractor is responsible for selecting appropriate means, methods, and sequences of construction, including microtunnel excavation equipment and shaft excavation initial support systems and ground water control systems, to perform the Work. The Contractor’s selected means, methods, and sequences of construction shall meet all of the requirements of the Contract Documents. The Contract Documents require that the design of the initial support systems, groundwater control systems, jacking pipe, and certain components associated with microtunneling are to be performed by a Professional Engineer licensed in the State of Texas, who is employed or retained by the Contractor.

4.1 SHAFT CONSTRUCTION

The initial support systems associated with shaft excavations are to be watertight and shall be fully supported and braced to prevent loss or movement of ground. This includes watertight break-in and break-out provisions for the microtunnel boring machine as well as a stable, watertight, bottom plug or temporary working slab at the bottom of the shaft excavation to prevent groundwater intrusion from the bottom of the shaft or boiling subgrades. Acceptable shaft support methods include secant piles, slurry walls, or interlocking sheet piles. Dewatering in order to install initial support systems or to perform shaft excavation shall be performed in accordance with applicable provisions of the Contract Documents.

Shafts shall be excavated to a sufficient size to accommodate the microtunnel excavation equipment and associated pipe installation, provide sufficient clearances for the proposed permanent construction elements at the locations of the shafts, especially for the Wet Well Shaft, and to allow for a safe working area.

4.2 MICROTUNNEL CONSTRUCTION

Microtunnel excavations are required for the subsurface conditions described herein in order to meet the specified horizontal and vertical alignment tolerances as well as limitations for ground movement and settlement in the Contract Documents. The means, methods, and sequences, for microtunneling shall take into account the location, the pipe diameter and length, the ground and groundwater conditions, and the nearby existing utilities, structures, and other facilities. Appropriate, immediate, continuous, and watertight ground support will be required during microtunnel excavation and construction. Due to the ground and groundwater conditions, pressurized face microtunneling is required. Microtunneling shall be performed in accordance with ASCE Standard 36-15, *Standard Design and Construction Guidelines for*

Microtunneling (ASCE 2015). Microtunnel excavation and construction will require a single pass construction method. The single pass construction method involves pipe jacking of a carrier pipe without installation of a separate casing pipe to facilitate installation of the carrier pipe.

A gassy atmospheric condition from naturally occurring methane or other gasses is not anticipated to be encountered during microtunnel excavation as organic deposits that tend to produce methane gas were not observed to be present from the geotechnical investigation. Therefore, the microtunnel excavations associated with this Project are to be classified as "not gassy" as defined by OSHA.

4.2.1 Stickiness and Clogging Potential of Microtunnel Excavation Equipment

Clays and silts have properties that can result in the clogging of tunnel excavation equipment (Thewes and Burger 2004). Clays with a high potential of clogging can impede or stop progress of tunnel excavation and may also result in increases in required jacking pressures associated with tunnel excavation. Studies suggest that the stickiness of a clay can be correlated based on the consistency index and plasticity index of the clay. The consistency index is a function of the natural moisture content, the liquid limit, and the plasticity index. Analysis of the laboratory data presented in the GDR indicate the soils have a low to high potential to clog the microtunnel excavation equipment. The clogging potential for the materials encountered during the geotechnical investigation for the microtunnel excavations is shown in Figure 1.

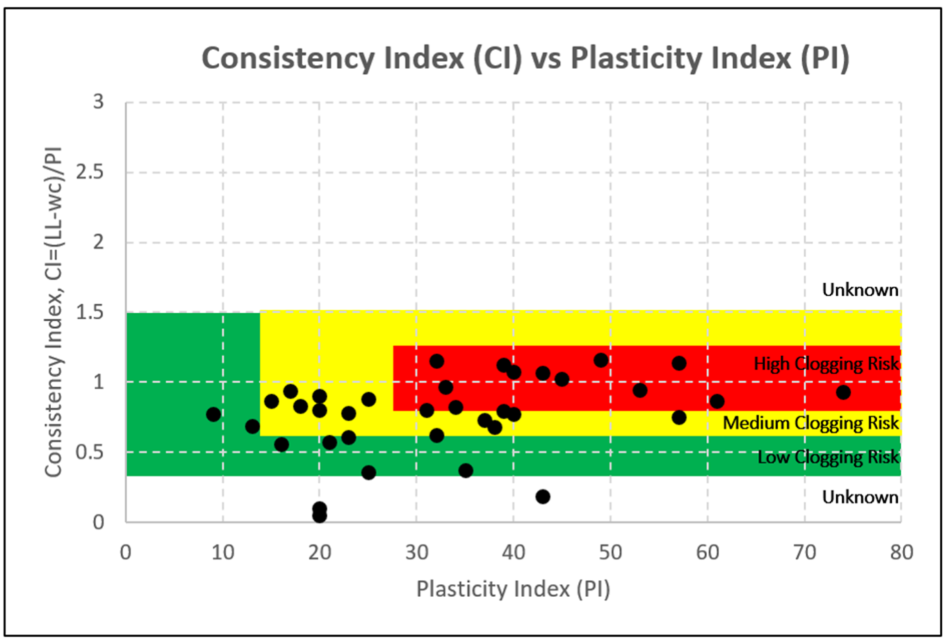

Figure 1: Clogging Potential

The following baselines related to stickiness and clogging potential of the microtunnel excavation equipment shall apply for the microtunnel excavations for the Project:

For baseline purposes, materials encountered will have a high potential to clog the microtunnel excavation equipment. Therefore, the Contractor shall utilize ground conditioning additives or other techniques to prevent clogging of the microtunnel excavation equipment as required by the Contract Documents.

4.3 SETTLEMENT MONITORING

Excessive overcut during microtunnel excavation and excess or uncontrolled spoil removed from the microtunnel excavation may result in settlement of the ground surface, existing utilities, structures, and/or other facilities. Construction of temporary initial support systems associated with shaft excavations into the soils could also induce settlement. Dewatering and inflow of groundwater into excavations could cause settlement. Shaft and microtunnel excavations require settlement monitoring as required by the Contract Documents. The ground surface and existing utilities, structures, and other facilities, as applicable, are to be monitored for settlement adjacent to shaft excavations and along the microtunnel excavations as required by the Contract Documents.

5.0 REFERENCES

American Society of Civil Engineers (ASCE). (2015) ASCE/CI Standard 36-15, Standard Design and Construction Guidelines for Microtunneling, Reston, Virginia.

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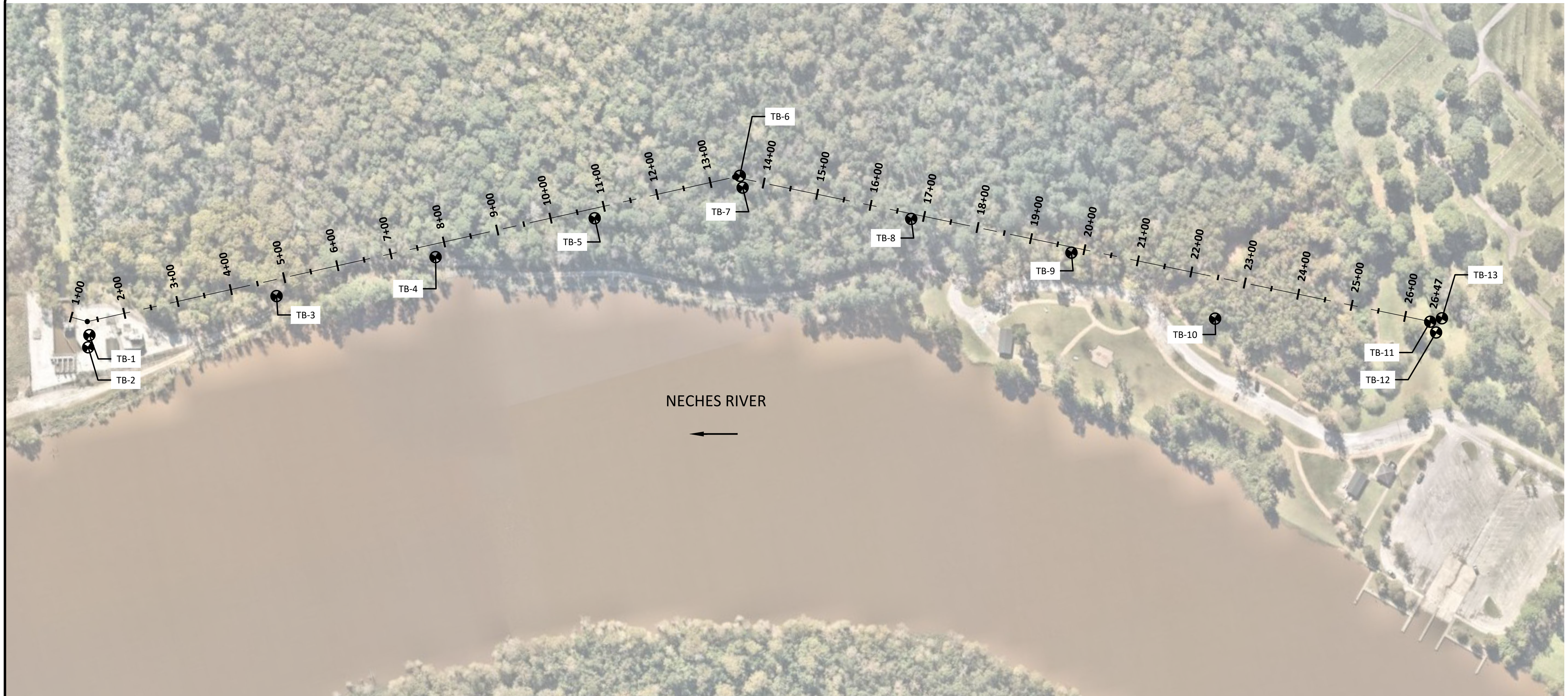
APPENDIX A
Geotechnical Plan and Profile



NOTES:

1. AERIAL IMAGERY HEREIN WAS OBTAINED FROM NEARMAP AND WAS TAKEN IN OCTOBER 2020 AND JANUARY 2021.
2. TOPOGRAPHIC DATA SHOWN HEREIN IS BASED UPON A FIELD SURVEY PERFORMED BY SOUTEX SURVEYORS & ENGINEERS IN MARCH 2021.
3. THE SURFACE ELEVATIONS OF EACH OF THE BORINGS ARE EXTRAPOLATED FROM TOPOGRAPHIC DATA AND ARE NOT THE ACTUAL SURVEYED ELEVATIONS WHERE THE BORINGS WERE PERFORMED.
4. THE NORTHING AND EASTING COORDINATES OF EACH OF THE BORINGS ARE APPROXIMATE AND ARE NOT THE ACTUAL SURVEYED LOCATIONS WHERE THE BORINGS WERE PERFORMED.

BORING TABLE

BORING NO.	STATION	OFFSET	NORTHING	EASTING	BORING SURFACE EL.	BORING DEPTH
TB-1	1+29.28	25.68 R	13991391.54	3520785.72	12.40 FT	40 FT
TB-2	1+23.16	49.92 R	13991412.81	3520792.80	12.40 FT	40 FT
TB-3	4+79.14	29.93 R	13991398.12	3520435.69	4.00 FT	30 FT
TB-4	7+79.09	23.86 R	13991393.47	3520135.71	4.21 FT	30 FT
TB-5	10+79.04	17.79 R	13991388.82	3519835.74	4.53 FT	30 FT
TB-6	13+54.55	4.00 L	13991372.35	3519559.29	3.47 FT	35 FT
TB-7	13+63.93	15.91 R	13991394.35	3519559.04	3.47 FT	35 FT
TB-8	16+77.95	9.20 R	13991518.93	3519270.71	4.00 FT	30 FT
TB-9	19+77.96	10.12 R	13991644.63	3518998.30	4.00 FT	30 FT
TB-10	22+60.15	74.94 R	13991820.99	3518768.68	4.00 FT	30 FT
TB-11	26+46.97	0.19 R	13991914.01	3518385.84	18.89 FT	50 FT
TB-12	26+61.64	17.25 R	13991935.62	3518379.59	18.82 FT	50 FT
TB-13	26+66.86	0.19 L	13991912.72	3518363.38	18.82 FT	50 FT

0 200' 400'
SCALE IN FEET
HORIZONTAL

Freese and Nichols, Inc.
Texas Registered Engineering Firm F-2144

F&N JOB NO. BMT20326
DATE 09/08/2021
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DESIGNED BCG
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CITY OF BEAUMONT
COLLIERS RAW WATER PUMP STATION
CIVIL
GEOTECHNICAL BASELINE REPORT
GEOTECHNICAL PLAN VIEW

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1
FIGURE

LEGEND

LEAN CLAY (CL)

FAT CLAY (CH)

CLAYEY SAND (SC)

SILTY SAND (SM)

POORLY GRADED SAND (SP)

POORLY GRADED SAND W/ SILT (SP-SM)

ORGANIC CLAY (OH)

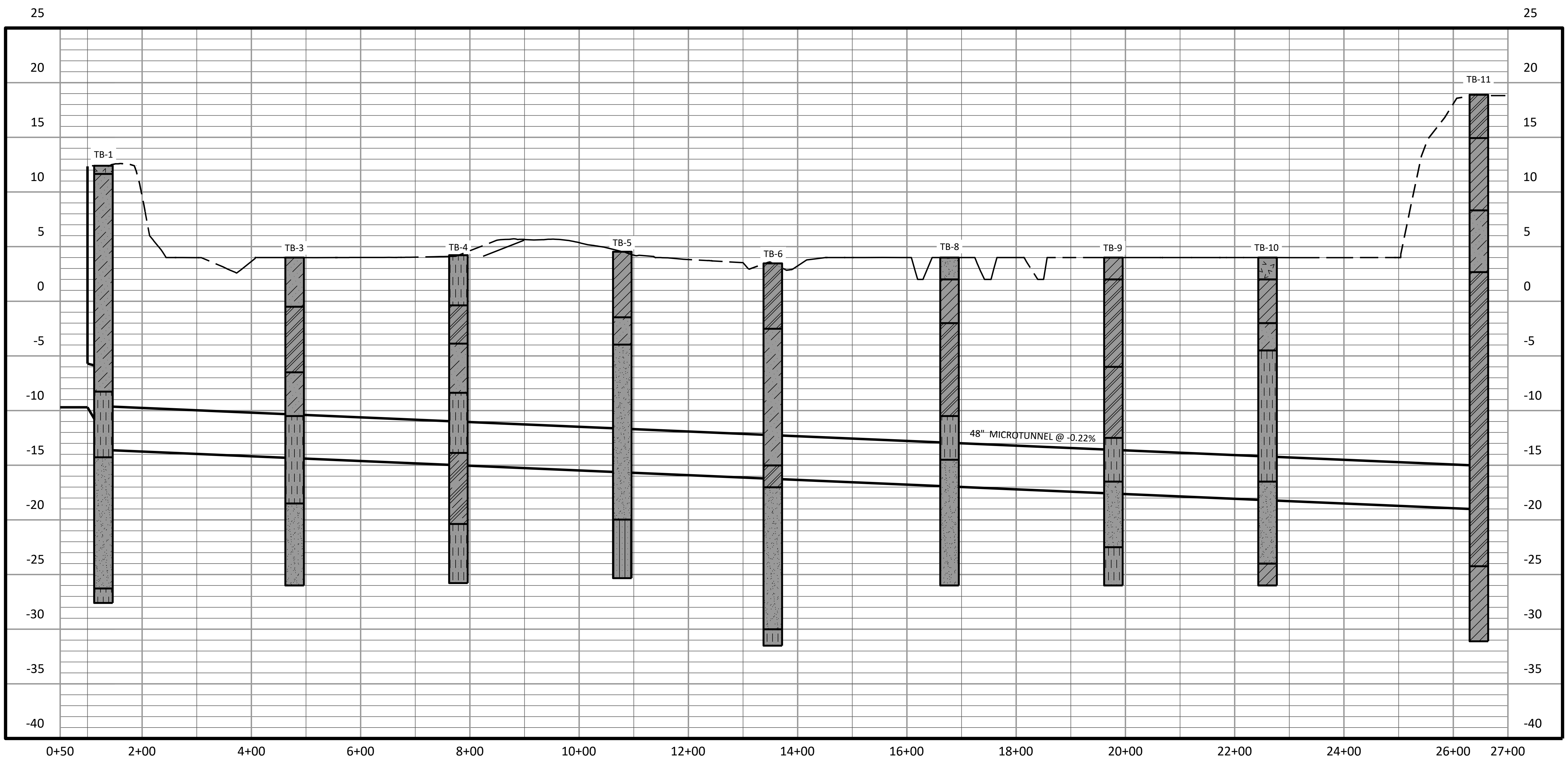
FILL

0 200' 400'
SCALE IN FEET
HORIZONTAL

0 10' 20'
SCALE IN FEET
VERTICAL

NOTES:

1. BORINGS TB-2, TB-7, TB-12, AND TB-13 ARE NOT SHOWN IN PROFILE FOR CLARITY.
2. MANHOLES AND SHAFTS NOT SHOWN IN PROFILE FOR CLARITY.



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GEOTECHNICAL PROFILE VIEW

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2

FIGURE